Energy resources and energy transfers

Pearson Edexcel · International GCSE · Physics

Energy: stored, transferred, wasted

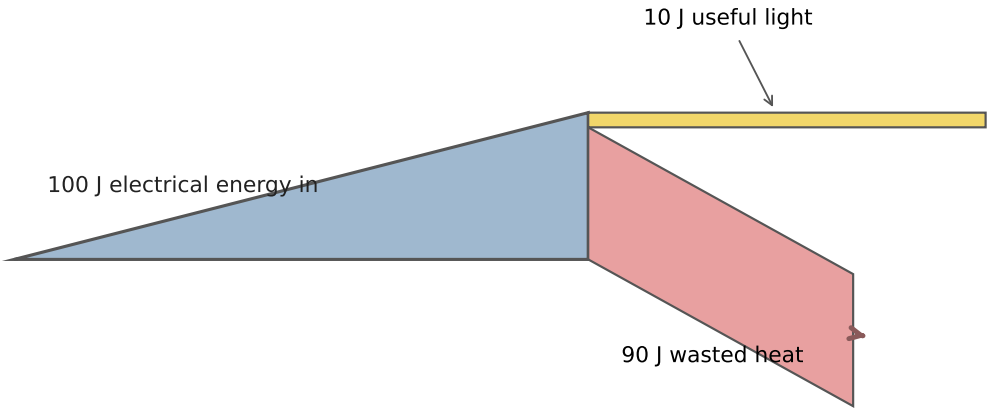
Nothing uses energy up – energy only moves between **stores** and leaks along the way. This section names the stores and transfers, measures **efficiency** with **Sankey diagrams**, follows heat by conduction, convection and radiation, links work, GPE and kinetic energy, and (P) weighs how electricity is generated.

Edexcel International GCSE Physics 4PH1, Section 4 (statements 4.1–4.19P). Units: joule (J), watt (W), newton (N), and (P) J/kg °C.

Energy transfers

Eight **stores**: chemical, kinetic, gravitational, elastic, thermal, magnetic, electrostatic, nuclear. Four **transfer pathways**: mechanically, electrically, by heating, by radiation (light and sound). Energy is **conserved** – the total is unchanged; devices just divert part of it from the store we want to ones we do not.

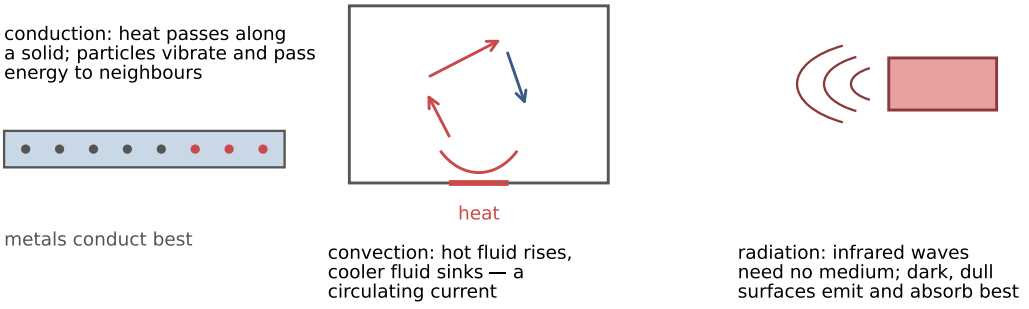
$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy output}} \times 100\%$$



Worked check. The lamp above: efficiency $= 10/100 \times 100 = 10\%$.

Thermal energy transfer

Heat moves three ways, each with its own mechanism and each beaten by a different defence.



Conduction : particle vibrations pass energy along a solid – fast in metals (free electrons). **Convection** : fluid warms, expands, becomes less dense and rises; cooler fluid sinks to replace it – sea breezes, radiators heating rooms. **Radiation** : infrared waves travel through a vacuum; **dark, dull surfaces** are the best emitters and absorbers; light, shiny surfaces reflect. Reducing unwanted transfer: insulation (cavity wall, loft, double glazing cuts conduction and convection; shiny foil reflects radiation).

Work, power and the energy equations

$$W = F \times d \qquad GPE = mgh \qquad KE = \tfrac{1}{2}mv^2 \qquad P = \frac{W}{t}$$

Work done equals energy transferred. Falling, GPE converts to KE (minus work against drag).

Worked check. A 2 kg book lifted 1.5 m at g = 10 N/kg: $GPE = 2 \times 10 \times 1.5 = 30$ J. Dropped, at the ground $KE = 30$ J $\rightarrow v = \sqrt{2 \times 30/2} = \sqrt{30} \approx 5.5$ m/s. A 60 W lamp runs 10 s: $W = 60 \times 10 = 600$ J.

Energy resources and electricity generation (P)

Every power station is an energy-transfer chain from a store to electricity; the table names the seven the specification requires.

Method	Energy transfer	Advantages	Disadvantages
wind	kinetic → electrical	renewable, no fuel cost	unreliable, visual/noise impact
hydroelectric	gravitational → electrical	renewable, instant supply	floods valleys, few sites
geothermal	thermal → electrical	renewable, steady	few suitable locations
solar heating	thermal (hot water)	renewable, no running cost	daytime/cloud dependent
solar cells	light → electrical	renewable, silent	expensive, low intensity output
fossil fuels	chemical → thermal → electrical	reliable, concentrated	CO_2 emissions, non-renewable
nuclear	nuclear → thermal → electrical	huge energy per kg, no CO_2	radioactive waste, decommissioning

Check yourself

1. Name four energy stores and two transfer pathways.
2. A motor uses 500 J and delivers 350 J of useful work. Calculate the efficiency.
3. Name the three thermal transfer methods and the one needing no medium.
4. Which surfaces emit infrared best?
5. State two ways a house reduces unwanted heat loss.
6. Calculate the work done by a 40 N force moving 3 m.
7. Calculate the KE of a 800 kg car at 20 m/s.
8. A heater transfers 12 000 J in 30 s. Calculate its power.
9. (P) Give one advantage and one disadvantage each of wind and nuclear power.
10. (P) Which two renewable methods extract energy already stored as heat in the ground or in falling water?

Answers: 1 chemical, kinetic, gravitational, thermal (also elastic, magnetic, electrostatic, nuclear); mechanically and electrically (also heating, radiation); 2 $350/500 \times 100 = 70\%$; 3 conduction, convection, radiation – radiation needs no medium; 4 dark, dull (matt black) surfaces; 5 loft/cavity-wall insulation and double glazing (also reflective foil, draught excluders); 6 $W = 40 \times 3 = 120$ J; 7 $KE = \frac{1}{2} \times 800 \times 400 = 160\,000$ J; 8 $P = 12\,000/30 = 400$ W; 9 (P) wind – renewable with no fuel cost, but unreliable and visually intrusive; nuclear – enormous energy per kilogram with no CO_2, but radioactive waste must be stored safely for centuries; 10 (P) geothermal (ground heat) and hydroelectric (gravitational store of water).